Metabolic Expenditure in Pregnant Women Enrolled in a Randomized Study of Walking

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Abstract

Preeclampsia is a disorder that occurs in 5-8% of pregnancies. What begins as elevated blood pressure and proteinuria can threaten the lives of both mother and fetus in the absence of treatment. Although the specific cause of preeclampsia is unknown, maternal risk factors for developing the condition include obesity, preexisting high blood pressure, diabetes, and endothelial dysfunction, among others (Preeclampsia Foundation, 2013). Interventions that decrease the incidence of preeclampsia and remain appropriate for the physiologic changes in pregnancy and the well-being of the fetus are needed. The purpose of this study was to assess the self-reported physical activity of pregnant women who enrolled in a randomized trial of a walking intervention. Women (n=123) who were enrolled in the study entitled "Exercise Intervention to Reduce Recurrent Preeclampsia" (R01 NR05375) had a history of preeclampsia, were sedentary, and were motivated to enter an intervention to reduce the likelihood of the recurrence of preeclampsia. Informed consent was administered and the participating women were randomized, resulting in 61 women in the attention control group and 62 women in the walking intervention group. Participants were 28.6 ± 5.25 (mean ± SD) years of age and were enrolled in the study at an average gestational age of 15.96 ± 3.02 weeks. The racial distribution of the sample was 19.5% African-American and 79.7% Caucasian. Participants completed the Paffenbarger Physical Activity Questionnaire at three time points during their pregnancy to assess activity. Data were calculated as metabolic equivalents (METs), an expression of energy expenditure. Although both study groups has similar METs per 24 hours at each measurement, participants in the walking intervention did reduce light activity and increase higher levels of activity as compared to women in the attention control group.

Key Terms: Preeclampsia, Paffenbarger, Metabolic Equivalents, Exercise, Pregnancy

Background

Globally, maternal mortality remains a large concern. The World Health Organization (WHO) reports that 287,000 women died in 2010 during and following pregnancy and childbirth (World Health Organization, 2012). Not only are a large number of women dying at a critical time in their own and their families' lives, but 99% of these tragedies are concentrated in developing countries (WHO, 2012). Preeclampsia and eclampsia are listed among the top four causes of maternal mortality (WHO, 2012).

Preeclampsia is a disorder that occurs during pregnancy and is characterized by hypertension, proteinuria and edema. This triad was named preeclampsia when it was recognized that these three factors were present in pregnancy preceding the onset of seizures. Eclampsia is the name that was given to seizures that occur during pregnancy. It is estimated that 5-8% of pregnancies will result in the development of preeclampsia (Preeclampsia Foundation, 2013). Complications for the mother include abruptio placentae, HELLP syndrome (hemolysis, elevated liver enzymes, and low platelet count), and respiratory, renal, and neurological effects (Mattar & Sibai, 2000). The major effects on the infant are due to preterm birth and include respiratory distress, jaundice, feeding difficulties, prolonged hospitalization (Duley, 2009), and low birth weight (Backes et al., 2011).

If left untreated, the condition can be fatal for both the mother and baby. The only definitive treatment is delivery, after which the condition resolves. However, women with a history of preeclampsia are more at risk for additional health problems related to cardiovascular disease later in life. Systematic reviews and meta-analyses report that women who have had pre-eclampsia have an increased risk of cardiovascular disease, including an almost fourfold increased risk of hypertension and an approximately twofold increased risk of fatal and non-fatal ischemic heart disease, stroke, and venous thromboembolism in later life (Bellamy, Casas, Hingorani, & Williams, 2007, p. 11).

Although the exact link between preeclampsia and cardiovascular disease is not known, there is evidence that endothelial cell dysfunction is a common factor in both disease processes. Endothelial dysfunction is an early step in atherosclerosis. Oxidative stress is evident in both cardiovascular disease and preeclampsia, and is involved in the exacerbation of endothelial dysfunction and atherosclerosis.

Oxidative stress is the total burden placed on the body by the production of free radicals in the normal course of metabolism. The body has defenses against these cell-damaging free radicals, including some that donate electrons to the free radical to stop the damage. Vitamins C and E are antioxidants, and there is support for the use of supplements to enhance antioxidant forces. Exposures to natural and artificial radiation, toxins in air, food and water; and miscellaneous sources of oxidizing activity, such as tobacco smoke or stress, may increase oxidation and the release of free radicals. The damage to cells caused by free radicals, may exceed these protective response mechanisms, and, can lead to atherosclerosis, among other things (Roberts, Pearson, Cutler, Lindheimer, & National Heart Lung and Blood Institute, 2003). In relationship to preeclampsia, it is hypothesized that free radicals created because of poor perfusion between the placenta and maternal blood supply lead to oxidative stress. Additional theories about the pathophysiology of preeclampsia exist but even without concrete knowledge of the abnormal mechanisms involved in the condition, the clear correlation between preeclampsia and cardiovascular disease can provide a starting point for designing interventions.

Increasing physical activity is one intervention of interest in reducing preeclampsia. The precise mechanism by which physical activity might reduce preeclampsia is not known. Yeo and

Davidge (2001) describe the probable involvement of oxidative stress as a mechanism. In a person who does not exercise regularly, the body's response to exercise activity results in oxidative stress. The response to free radicals released during exercise depletes the body's natural antioxidant stores. This lack of antioxidants coupled with oxidative stress caused by the exercise triggers the release of the enzyme superoxide dismutase, which acts as an antioxidant (Yeo & Davidge, 2001). The body of an individual who does exercise regularly is accustomed to a more rapid release of superoxide dismutase to resolve the imbalance of free radicals and antioxidants (Yeo & Davidge, 2001). The underlying idea is that women who regularly exercise have trained their bodies to deal with oxidative stress so that when it occurs during pregnancy, their bodies are prepared to neutralize its harmful effects. In addition to reduction of oxidative stress, Weissgerber, Wolfe, and Davies hypothesized two additional mechanisms that could mediate the positive effects of physical activity on preeclampsia, namely stimulation of placental growth and vascularity, and exercise-induced reversal of maternal endothelial dysfunction. They suggest the usefulness of further studies that can accurately measure physical activity while assessing some of the biochemical pathways they proposed (Weissgerber, Wolfe, & Davies, 2004). However, such well-controlled studies are lacking.

Researchers have explored how a stretching intervention may reduce preeclampsia (Yeo, 2010), but have yet to attempt a moderate intensity activity such as walking. Increasing physical activity has been recommended by the American Heart Association and supported by physical activity interventions as a means of preventing the onset of cardiovascular disease or improving symptoms in those with established disease (Thompson et al., 2003). Since women who have experienced preeclampsia are at increased risk of cardiovascular disease, and women with recurrent preeclampsia have a greater likelihood of cardiovascular disease, it follows that interventions that are successful in improving cardiovascular status should be beneficial in pregnant women at risk.

According to the Centers for Disease Control and Prevention (CDC), almost half of American adults do not meet the recommended exercise requirements of 150 minutes of moderate intensity aerobic activity every week (National Center for Health Statistics, 2013)(Centers for Disease Control and Prevention, 2011). In addition, it is known that during pregnancy women decrease their level of activity (Fell, Joseph, Armson, & Dodds, 2009). Therefore, women who are regularly inactive would be expected to become even more sedentary during pregnancy.

Physical exercise is widely known to result in many benefits including increased muscle tone, increased energy (The American College of Obstetricians and Gynecologists, 2011) and lowered blood pressure (Brook et al., 2013). Thirty minutes of moderate exercise per day is the suggested minimum amount of exercise (Committee on Obstetric Practice, 2002). During pregnancy, the American College of Obstetricians and Gynecologists (ACOG) recommends walking, swimming, cycling, and aerobics as good forms of exercise. Continuing pre-pregnancy exercise routines is generally encouraged, although the intensity of the exercise may need to be decreased as the pregnancy progresses. ACOG discourages participation in contact sports, becoming overheated during activity, and exercises requiring a woman to lie on her back due to the risk of harming the developing fetus (ACOG, 2011). Furthermore, a study examining the safety of exercise during pregnancy concluded that low to moderate intensity exercise can be considered safe (O'Connor, Poudevigne, Cress, Motl, & Clapp, 2011).

There is no evidence that women are willing to increase physical activity during pregnancy, however, maternal behavior change during pregnancy has been reported. In a study of 115 women, more than 49% of the women made changes in their diet, exercise pattern, smoking habits, vitamin intake, and alcohol use during pregnancy. The motivation for these changes was not explored, but was speculated to be concern for the well being of the fetus (Higgins, Frank, & Brown, 1994).

The Health Promotion Model developed by Nola Pender can explain why women would be willing to make a health behavior change during pregnancy. The model takes into account the influences that personal characteristics and experiences, as well as knowledge regarding the health promotion activity, have when attempting a behavior change. An individual's situation, relationships, and own thoughts about the benefits or barriers to making a change all play a role in determining whether or not to pursue a health promoting behavior (Potter & Perry, 2009). The experience of increased risk of a pregnancy complication or later onset cardiovascular disease might precipitate a desire for a behavior change, and the information provided during the intervention might increase the likelihood of adherence to regular exercise. Thus, the Health Promotion Model would suggest that these women would have more reasons to participate and a stronger sense of the benefits of trying an exercise intervention because of their past experiences with preeclampsia.

Based on these physical activity recommendations for the reduction of cardiovascular risk and exercise during pregnancy, a study was devised to test if exercise initiated in pregnancy, when the woman was sedentary prior to pregnancy, would reduce the recurrence of preeclampsia in a group of women who previously experienced preeclampsia. In this study, participants were randomized to either a walking or attention control group. Women in the walking group were instructed to walk at a moderate pace for 30 minutes for at least 5 days per week. In addition, walkers received telephone calls from the project nurse every 2 weeks. The project nurse provided women randomized to the control group general health and pregnancy information every 2 weeks as an attention control. The primary aim of the study was to examine the effect of increased physical activity on the recurrence of preeclampsia. Secondary aims were to explore probable mechanisms and to better understand health behavior change during pregnancy.

Purpose

The purpose of this study is to describe data regarding the physical activity of study participants as reported on the Paffenbarger Physical Activity Questionnaire, specifically noting if the pattern of physical activity differed between women randomized to a walking intervention as compared to an attention control group at baseline, time 2, and time 3. We hypothesized that both groups would report similar levels of activity at baseline, but the walking group would show a larger increase in activity at times 2 and 3.

Review of Literature

Many research articles have explored the topic of exercise during pregnancy. They have considered various types of activities, ranging from basic aerobic exercise such as walking (Amezcua-Prieto et al., 2013) to strength training (O'Connor et al., 2011), as well as the many benefits exercise can bring to both the mother and fetus (Clapp, 2000). Included in the list of maternal benefits are “improved cardiovascular function” and “limited weight gain and fat retention” (Clapp, 2000, p. 273). Both of these outcomes are important in the prevention of preeclampsia due to the common cardiovascular pathways involved. Another of his studies analyzed the effect of exercise on the growth of the fetus and placenta. He found that women who performed weight-bearing exercise at a moderate intensity from the start of the pregnancy improved the functional capacity of their placentas and delivered larger, leaner babies (Clapp, Kim, Burciu, & Lopez, 2000). A similar follow-up study concluded that the timing and intensity of the exercise in relation to the pregnancy had an important effect on several characteristics. Women who completed moderate to high volumes of moderate intensity exercise towards the middle and end of the pregnancy decreased the birth size of the placenta and baby. When the amount of exercise was instead decreased at that same point of the pregnancy, increased growth of the placenta and baby occurred (Clapp et al., 2002).

Nonetheless, physical exercise cannot attempt to address the issue of preeclampsia if women are not exercising. Decreasing physical activity during pregnancy is a frequent pattern. In an observational study investigating pregnant women's weight bearing exercise, almost half of the subjects were reported to have "stopped entirely or reduced their overall exercise volume by at least 75% before the 12th week of pregnancy" (Clapp, 2008, p. 489.e1). However, the same study found that women who were successful in maintaining their exercise during pregnancy had a "level of fitness well above and indices of cardiovascular risk well below those present in both the general populace and women who temporarily stopped exercise during pregnancy" (Clapp, 2008, p. 489.e5). The participants who continued to exercise experienced benefits in their cardiovascular health, whereas those who stopped exercising forfeited those benefits. A more recent study analyzed women's amount of leisure time physical activity in both the year before and during their pregnancies. Activity intensity and duration was reported to have decreased in "a substantial proportion" of the women after comparing the two time periods (Amezcua-Prieto et al., 2013, p. 129).

However, not all of the women in the study decreased their activity levels. Participants who reported tobacco cessation during pregnancy were more likely to meet or exceed exercise recommendations. The authors comment, "the strength of this association suggests that pregnant women maintain or adopt healthy lifestyles perceived to be of benefit to the fetus" (Amezcua-

Prieto et al., 2013, p. 129). This finding opens up the possibility that, if pregnant women began to view the effects of a sedentary lifestyle just as detrimental to their fetus as smoking, they may be more motivated to stay active during pregnancy (Amezcua-Prieto et al., 2013).

Although instituting a walking intervention appears to be straightforward, the decision must be made whether the required amount of exercise should be done in one time period or if it can be broken up into smaller pieces throughout the day. A study entitled “Comparison Between the Effects of Continuous and Intermittent Aerobic Exercise on Weight Loss and Body Fat Percentage in Overweight and Obese Women: A Randomized Controlled Trial” concluded that the intermittent style of exercise resulted in more weight loss in study participants (Alizadeh et al., 2013). Similar studies concluded that either continuous or intermittent exercise can improve cardiovascular fitness, as well as weight loss and exercise participation, however, adherence to an activity prescription for intermittent short-bout (SB) exercise was greater as compared to one continuous long-bout (LB) of exercise. In fact, women in a SB group reported exercising on a greater number of days and for a greater total duration than the LB group (Jakicic, Wing, Butler, & Robertson, 1995; Jakicic, Winters, Lang, & Wing, 1999, p. 1560). The studies, taken together, provide evidence of improved weight loss in intermittent exercise, perhaps explained by improved adherence to the exercise prescription.

Of particular note is a finding from a study that asked sedentary, overweight women to commit to using intermittent periods of moderate exercise to accumulate 30 minutes of exercise for 5 days of the week. This study lasted for 32 weeks and reported an 80% adherence rate to the exercise regimen (Snyder, Donnelly, Jabobsen, Hertner, & Jakicic, 1997, p. 1187). This high rate of adherence suggests that since intermittent or short bouts of exercise have proven to be comparable to longer sessions of exercise, a walking intervention that recommends women to walk in short bouts may have a greater compliance rate than one that asks women to complete the exercise all at once. In order to understand the compliance rate, an appropriate assessment tool must be used to assess physical activity.

An assessment tool is vital to accurately understand a participant's amount and level of physical activity, and, in this study, must also be suitable for use with pregnant women. Unfortunately, most physical activity questionnaires have been developed and studied with male subjects, and the physiological changes that occur during pregnancy may make the questionnaires less accurate with pregnant subjects. A study entitled "Validity and Repeatability of a Short Pregnancy Leisure Time Physical Activity Questionnaire" compared the validity of a questionnaire with pedometer and activity logbook data. The questionnaire was determined to be "reasonably valid but not repeatable among pregnant women with less than 34 weeks' gestation in assessing the type of LTPA [leisure time physical activity] recommended during uncomplicated pregnancy" (Aittasalo, Pasanen, Fogelholm, & Ojala, 2010, p. 116). The subjects' recall of activity proved valid but the limitations of memory prevented the questionnaire from being repeatable.

A similar study compared a physical activity questionnaire with objective data from an actigraph (also known as a CSA accelerometer). The questionnaire was determined to be a "reliable instrument and provides a reasonable measure of pregnancy physical activity" (Chasan-Taber et al., 2004, p. 1755). One benefit of questionnaires over more objective measurements of activity, such as pedometers and actigraphs, is that a questionnaire can better measure household versus traditional exercise activity. This is important to be able to assess, as household activity is most likely a large presence in the lives of pregnant women.

A different group of researchers performed a systematic review of twenty studies that investigated physical activity during pregnancy. They identified some issues regarding the timing of questionnaires as some studies asked women to report their activity levels after giving birth, thus introducing bias of historical recall. They concluded that "assessments should take place at multiple time points during pregnancy, such that studies can identify the etiologically important time period for the effect of recreational physical activity on birth outcomes" (Chasan-Taber, Evenson, Sternfeld, & Kengeri, 2007, p. 102-103). These articles imply that a physical assessment tool for pregnancy should include the following characteristics: self-report method of recall, questions regarding household activity, and administration during several different times of the pregnancy. Another aspect of activity assessment includes the use of metabolic equivalents to help categorize exercise intensity in pregnant women.

Metabolic equivalents are commonly used to quantify the amount of energy used to perform a specific activity. One metabolic equivalent of task (MET) is defined as the resting metabolic rate, that is, the amount of oxygen consumed at rest [resting VO_2], sitting quietly in a chair, approximately 3.5 ml O_2/kg/min (1.2 kcal/min for a 70-kg person) (Jette, Sidney, & Blumchen, 1990, p. 555). A chart called the Compendium of Physical Activities serves as a guide for activity intensities by assigning MET values to many exercise and leisure activities. For example, outdoor bicycling is divided into 18 different subcategories based on speed or terrain. The corresponding MET values range from 3.5 METs for "bicycling, leisure, 5.5 mph" to 16 METs for "bicycling, mountain, competitive, racing" (Ainsworth, Haskell, Herrmann, & et al., 2011). The higher the MET value, the more energy the activity requires. This may seem like a very straightforward way to measure the energy cost of a specific activity, but the accuracy of MET values is debated.

One study re-assessed the amount of oxygen consumed while at rest (equal to 1 MET) and found the value to be closer to 2.6 ml O_2/kg/min, instead of the traditional definition, which placed the value at 3.5 ml O_2/kg/min (Byrne, Hills, Hunter, Weinsier, & Schutz, 2005, p. 1115). This means MET values may actually overestimate the amount of energy it takes to complete an activity. In contrast, adiposity was shown to lower the resting VO_2, thus causing a standardized MET value to underestimate the amount of energy being used in that population during an activity (Byrne et al., 2005, p. 1118). Pregnancy, with all its physiological alterations, may also affect the accuracy of MET values, as the basal metabolic rate (BMR) is known to increase during pregnancy (Smith, Foster, & Campbell, 2011, p. 8). Thus, pregnancy would affect the validity of an MET value. Byrne et al. acknowledges, "the MET system was not designed to give precise estimates of the energy cost of physical activity, but rather it was developed as a system for use in survey research to standardize intensities of physical activities" (Byrne et al., 2005, p. 1117). Although the MET system may not be a perfect reflection of an activity's intensity, but at the very least, it allows researchers a common language to use when categorizing how strenuous an activity may be.

Methods

This study was a secondary analysis of data collected as part of a randomized controlled trial with a group of pregnant women to test whether a walking intervention could reduce the recurrence of preeclampsia in women at high risk ("Exercise Intervention to Reduce Recurrent Preeclampsia" R01NR05275). In this secondary analysis, the energy expenditure of study participants was calculated so that the activity of women in the intervention group could be compared to the activity in the attention control group.

Sample

Subjects in the original study were recruited from an urban hospital in the Northeast. A past history of preeclampsia was required to be part of the study. Existing chronic medical conditions that place a women at risk for preeclampsia such as essential hypertension, diabetes, or multiple gestation excluded potential subjects. Subjects were also excluded if they had experienced preeclampsia in more than one previous pregnancy or if their current pregnancy was with a different partner than the previous pregnancy that had been complicated by preeclampsia.

Instrument

The Paffenbarger Physical Activity Questionnaire was first used in a study entitled "Physical Activity as an Index of Heart Attack Risk in College Alumni" (Paffenbarger, Wing, & Hyde, 1978). The questionnaire was meant as a tool to assess leisure activity. It contains eight main questions which ask about the number of city blocks walked per day, usual pace of walking, flights of stairs climbed per day, participation in a recreational sport, subject's attitude toward exercising, if subject is activity regularly, level of exertion during exercise, and amount of time spent in five categories (vigorous, moderate, light, sitting, and sleeping activities) during a typical weekday and weekend day (Paffenbarger et al., 1978). A more recent study entitled "Factors Associated with Changes in Leisure Time Physical Activity During Early Pregnancy" used the Paffenbarger Physical Activity Questionnaire to assess subjects' activity. The authors comment, "the accuracy of the questionnaire was excellent, with a pooled Spearman r correlation coefficient (rs) of 0.90" (Amezcua-Prieto et al., 2013, p. 128). Therefore, this questionnaire has been determined suitable for use in a population of pregnant women.

Procedure

Participants in the parent study filled out the survey at three different points in their pregnancies, specifically at baseline (less than 18 weeks gestation), time 2 (24 to 26 weeks gestation) and time 3 (34 weeks gestation) during the course of the randomized trial. Two of the eight questions on the Paffenbarger Physical Activity Questionnaire were specifically analyzed (Paffenbarger et al., 1978). Question six which asks about regular activity was used to screen for participants. Those who responded that they were regularly active were not enrolled in the study. For subjects who did not report regular physical activity, their responses to question eight were used to track if there was any change in their activity during the intervention. MET values from the 2011 Compendium of Physical Activities (Ainsworth et al., 2011) were assigned to each category of activity (vigorous, moderate, light, sitting, and sleeping) and used to translate the hours into METs. For example, a participant reported light activity for 4 hours. Using 2 METs as the corresponding MET value for light activity, the 4 hours was multiplied by the 2 METs to yield 8 total METs for the total amount of light activity that day.

Data Analysis

Data were organized by subject and assessment time point so that study groups and change over time could be analyzed. The Statistical Package for the Social Sciences (SPSS) was used for the analysis. Mean values for the amount of activity reported (METs) in each category and overall were calculated for both the control and walking groups. In order to include data from women who partially completed the study, data were imputed for participants who did not finish. Means were calculated for both the raw and imputed data. Both sets of data were then compared using a paired samples test after performing a repeated measures ANOVA. The significance was calculated, using $p < 0.050$ as the level of significance with a 95% confidence interval.

Results

Sample

Participant retention was a challenge for the original study administrators. The study began with a total of 123 women enrolled. Participants were randomized to one of two conditions: a walking intervention or an attention control group. Both groups were comparable in size with 62 participants in the walking and 61 participants in the control group. The mean age of the participants upon enrollment in the study was 28.6 ± 5.25 years old, with an average gestational age of 15.96 ± 3.02 weeks. The racial distribution shows that the majority of the participants were Caucasian (79.7%) compared to African American (19.5%). Table 1 (below) summarizes these statistics.

Table 1.

Description of the sample

	Walker	Control
Number of women	62	61
Age at enrollment (mean ± S.D.)	28.47±5.26	28.79±5.29
Gestational age in weeks at enrollment (mean ± S.D.)	16.05±3.20	15.87±2.86
Race	33 W / 9 B	46 W / 15 B

Only 80 women completed the questionnaire at all three time points, resulting in a total dropout rate of 34.9%. The losses came from both the attention control and walking intervention groups. The attention control group lost 18 participants; the walking intervention group lost 25 participants.

Exercise Expenditure

The data were first summarized by study group and study assessment timepoint using descriptive statistics. The paired samples test was first performed on the raw data. Some significant differences were noted between specific time points. The attention control group significantly decreased their exercise expenditure between time 2 and time 3 (p = 0.018) and between time 1 and time 3 (p = 0.027). Whereas the control group had 2 significant time points from the raw data, the walking intervention group only reported one significant decrease in activity. This was seen between time points 2 and 3 (p = 0.025). After adding the imputed data, there were no significant differences between time points in either the attention control or walking intervention groups.

MET means were also graphed with standard error of mean bars to compare the two groups' activity level in the light, moderate, and vigorous categories. Significance was noted for the walking group as a decrease in light activity at time 2 (p = 0.023). At time 3, both groups were significantly different in their vigorous energy expenditure (p = 0.005). Illustration 1 (below) includes the graphs of the three categories of activity for both the attention control and walking interventions groups.

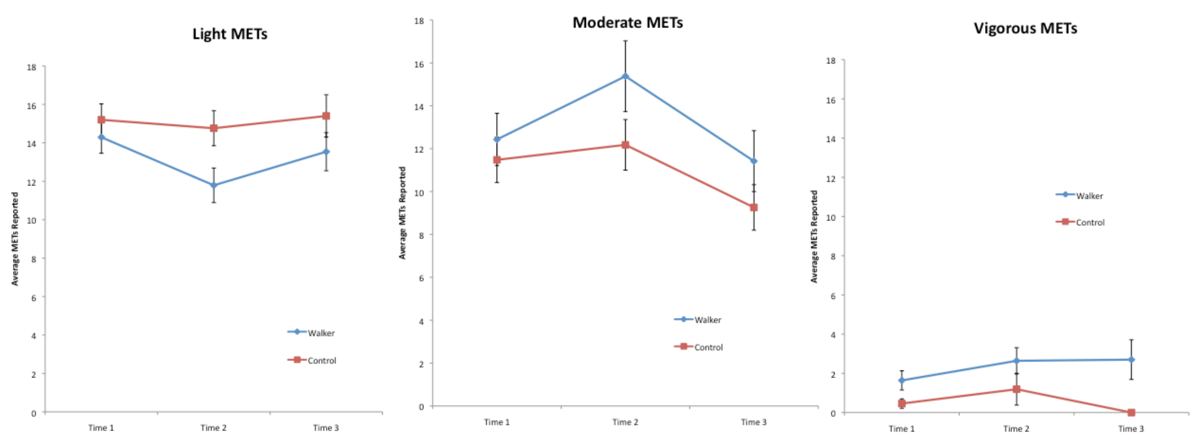

Illustration 1

Discussion

This secondary analysis assessed the physical activity of participants in a randomized control trial testing a walking intervention against an attention control group. The data were analyzed to determine if there were differences in metabolic expenditure between the walking and attention control groups at baseline, time 2, and time 3. After analyzing the data, there was no significant difference in the overall baseline activity levels for the participants in both groups. Participants in the walking group were seen to have increased their moderate and vigorous activity metabolic expenditure as compared to the attention control group during times 2 and 3.

These results were not unexpected. Because of the inclusion criteria for the study, it was highly likely that women who were selected to participate would have similar activity levels at baseline. In fact, women who had a preexisting exercise regimen were excluded from the study. In addition, it was desirable for the participants to reflect similar levels of metabolic expenditure at baseline, so that the effect of the intervention could be more clearly distinguished from other influencing factors. The fact that women in the walking intervention did increase their activity above their baseline levels is important to note. Typically, women decrease their physical activity by 75% or more by the 12th week of pregnancy (Clapp, 2008). Although the intervention did not produce as significant as a change in the walking group as may be desired, it did successfully help the participants to increase their activity levels during pregnancy.

Secondary aims of the parent study were to explore probable mechanisms of and to better understand health behavior change during pregnancy. Participants in the trial were encouraged to complete 30 minutes of walking in one continuous bout, or up to 3 short bouts totaling 30 minutes. Our results showed that the use of an intermittent style of exercise intervention did influence some women to alter their health behaviors. The use of short bout exercise has been shown to increase compliance in exercise interventions (Jakicic et al., 1999). However, the response in this study was not large. This is an expected finding that carries with it important implications for practice. Health behavior change involving exercise during pregnancy is a difficult change to initiate and maintain. The women in the walking intervention were both motivated to change based on their past experiences with preeclampsia and had the support of the project nurse, yet the study did not result in statistically significant differences between the walking and control groups. The women in the walking group who did manage to increase their activity may have benefited from the support of the project nurse as well as the short bout method of exercise. Social support and the use of a practical method of behavior change are important aspects for practitioners who counsel women about exercise during pregnancy to highlight.

Even though this study can provide some guidance for practice, it is not without limitations. As a secondary analysis of previously collected data, the original study design necessarily affects this current study. For example, the intended sample size for the study was 160 women per study group. Difficulties recruiting a high-risk pregnant population with stringent criteria and high dropout rates did not allow this size of group to be assembled. Because the participants all had a history of a high-risk pregnancy due to preeclampsia, primary care providers may have been more cautious in their recommendations during patient checkups. This may have led some practitioners to counsel women to decrease their physical activity, resulting in them dropping out of the study, at the first sign of an unusual event that might signal a possible complication. A stronger working relationship between the research team and the primary care providers could have given the primary care providers the confidence to encourage women to continue light exercise for a longer period of their pregnancy. These circumstances help explain the numbers of dropouts in the original study.

In conclusion, this secondary analysis has shown that an exercise intervention designed for pregnant women with a history of preeclampsia can help increase activity levels. Due to dropout rates and the physiologically stressors that make exercise during pregnancy difficult, a future study may need to focus on additional ways to support study participants in the hope of achieving more statistically significant results. However, the small increases in activity levels seen in the walking intervention suggest that behavior change during pregnancy is possible. Future studies may build on these findings by testing the exercise intervention utilized in this study with a group of women with uncomplicated pregnancies. This may prevent high dropout rates and allow the effect of the intervention design to be more clearly seen.

References

Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., & et al. (2011). 2011 compendium of physical activities: A second update of codes and MET values. *Medicine and Science in Sports and Exercise, 43*, 1575-1581.

Aittasalo, M., Pasanen, M., Fogelholm, M., & Ojala, K. (2010). Validity and repeatability of a short pregnancy leisure time physical activity questionnaire. *Journal of Physical Activity & Health, 7*(1), 109-118.

Alizadeh, Z., Kordi, R., Rostami, M., Mansournia, M. A., Hosseinzadeh-Attar, S. M., & Fallah, J. (2013). Comparison between the effects of continuous and intermittent aerobic exercise on weight loss and body fat percentage in overweight and obese women: A randomized controlled trial. *International Journal of Preventive Medicine, 4*(8), 881-888.

Amezcua-Prieto, C., Olmedo-Requena, R., Jimenez-Mejias, E., Mozas-Moreno, J., Lardelli-Claret, P., & Jimenez-Moleon, J. J. (2013). Factors associated with changes in leisure time physical activity during early pregnancy. *International Journal of Gynaecology and Obstetrics: The Official Organ of the International Federation of Gynaecology and Obstetrics, 121*(2), 127-131.

Backes, C. H., Markham, K., Moorehead, P., Cordero, L., Nankervis, C. A., & Giannone, P. J. (2011). Maternal preeclampsia and neonatal outcomes. *Journal of Pregnancy, 2011*, 214365.

Bellamy, L., Casas, J. P., Hingorani, A. D., & Williams, D. J. (2007). Pre-eclampsia and risk of cardiovascular disease and cancer in later life: Systematic review and meta-analysis. *BMJ (Clinical Research Ed.), 335*(7627), 974.

Brook, R. D., Appel, L. J., Rubenfire, M., Ogedegbe, G., Bisognano, J. D., Elliott, W. J., Fuchs, F. D., Hughes, J. W., Lackland, D. T., Staffileno, B. A., Townsend, R. R., Rajagopalan, S., & American Heart Association Professional Education Committee of the Council for High Blood Pressure Research, Council on Cardiovascular and Stroke Nursing, Council on Epidemiology and Prevention, and Council on Nutrition, Physical Activity. (2013). Beyond medications and diet: Alternative approaches to lowering blood pressure: A scientific statement from the american heart association. *Hypertension, 61*(6), 1360-1383.

Byrne, N. M., Hills, A. P., Hunter, G. R., Weinsier, R. L., & Schutz, Y. (2005). Metabolic equivalent: One size does not fit all. *Journal of Applied Physiology (Bethesda, Md.: 1985), 99*(3), 1112-1119.

Chasan-Taber, L., Evenson, K. R., Sternfeld, B., & Kengeri, S. (2007). Assessment of recreational physical activity during pregnancy in epidemiologic studies of birthweight and length of gestation: Methodologic aspects. *Women & Health, 45*(4), 85-107.

Chasan-Taber, L., Schmidt, M. D., Roberts, D. E., Hosmer, D., Markenson, G., & Freedson, P. S. (2004). Development and validation of a pregnancy physical activity questionnaire. *Medicine and Science in Sports and Exercise, 36*(10), 1750-1760.

Clapp, J. F.,3rd. (2000). Exercise during pregnancy. A clinical update. *Clinics in Sports Medicine, 19*(2), 273-286.

Clapp, J. F.,3rd. (2008). Long-term outcome after exercising throughout pregnancy: Fitness and cardiovascular risk. *American Journal of Obstetrics and Gynecology, 199*(5), 489.e1-489.e6.

Clapp, J. F.,3rd, Kim, H., Burciu, B., & Lopez, B. (2000). Beginning regular exercise in early pregnancy: Effect on fetoplacental growth. *American Journal of Obstetrics and Gynecology, 183*(6), 1484-1488.

Clapp, J. F.,3rd, Kim, H., Burciu, B., Schmidt, S., Petry, K., & Lopez, B. (2002). Continuing regular exercise during pregnancy: Effect of exercise volume on fetoplacental growth. *American Journal of Obstetrics and Gynecology, 186*(1), 142-147.

Committee on Obstetric Practice. (2002). ACOG committee opinion. exercise during pregnancy and the postpartum period. number 267, january 2002. american college of obstetricians and gynecologists. *International Journal of Gynaecology and Obstetrics: The Official Organ of the International Federation of Gynaecology and Obstetrics, 77*(1), 79-81.

Duley, L. (2009). The global impact of pre-eclampsia and eclampsia. *Seminars in Perinatology, 33*(3), 130-137.

Fell, D. B., Joseph, K. S., Armson, B. A., & Dodds, L. (2009). The impact of pregnancy on physical activity level. *Maternal and Child Health Journal, 13*(5), 597-603.

Higgins, P., Frank, B., & Brown, M. (1994). Changes in health behaviors made by pregnant women. *Health Care for Women International, 15*(2), 149-156.

Jakicic, J. M., Wing, R. R., Butler, B. A., & Robertson, R. J. (1995). Prescribing exercise in multiple short bouts versus one continuous bout: Effects on adherence, cardiorespiratory fitness, and weight loss in overweight women. *International Journal of Obesity and Related Metabolic Disorders : Journal of the International Association for the Study of Obesity, 19*(12), 893-901.

Jakicic, J. M., Winters, C., Lang, W., & Wing, R. R. (1999). Effects of intermittent exercise and use of home exercise equipment on adherence, weight loss, and fitness in overweight women: A randomized trial. *JAMA : The Journal of the American Medical Association, 282*(16), 1554-1560.

Jette, M., Sidney, K., & Blumchen, G. (1990). Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. *Clinical Cardiology, 13*(8), 555-565.

Mattar, F., & Sibai, B. M. (2000). Eclampsia. VIII. risk factors for maternal morbidity. *American Journal of Obstetrics and Gynecology, 182*(2), 307-312.

O'Connor, P. J., Poudevigne, M. S., Cress, M. E., Motl, R. W., & Clapp, J. F.,3rd. (2011). Safety and efficacy of supervised strength training adopted in pregnancy. *Journal of Physical Activity & Health, 8*(3), 309-320.

Paffenbarger, R. S.,Jr, Wing, A. L., & Hyde, R. T. (1978). Physical activity as an index of heart attack risk in college alumni. *American Journal of Epidemiology, 108*(3), 161-175.

Roberts, J. M., Pearson, G. D., Cutler, J. A., Lindheimer, M. D., & National Heart Lung and Blood Institute. (2003). Summary of the NHLBI working group on research on hypertension during pregnancy. *Hypertension in Pregnancy : Official Journal of the International Society for the Study of Hypertension in Pregnancy, 22*(2), 109-127.

Smith, K. M., Foster, R. C., & Campbell, C. G. (2011). Accuracy of physical activity assessment during pregnancy: An observational study. *BMC Pregnancy and Childbirth, 11*, 86-2393-11-86.

Snyder, K. A., Donnelly, J. E., Jabobsen, D. J., Hertner, G., & Jakicic, J. M. (1997). The effects of long-term, moderate intensity, intermittent exercise on aerobic capacity, body composition, blood lipids, insulin and glucose in overweight females. *International Journal* *of Obesity and Related Metabolic Disorders : Journal of the International Association for the Study of Obesity, 21*(12), 1180-1189.

Thompson, P. D., Buchner, D., Pina, I. L., Balady, G. J., Williams, M. A., Marcus, B. H., Berra, K., Blair, S. N., Costa, F., Franklin, B., Fletcher, G. F., Gordon, N. F., Pate, R. R., Rodriguez, B. L., Yancey, A. K., Wenger, N. K., American Heart Association Council on Clinical Cardiology Subcommittee on Exercise, Rehabilitation, and Prevention, & American Heart Association Council on Nutrition, Physical Activity, and Metabolism Subcommittee on Physical Activity. (2003). Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease: A statement from the council on clinical cardiology (subcommittee on exercise, rehabilitation, and prevention) and the council on nutrition, physical activity, and metabolism (subcommittee on physical activity). *Circulation, 107*(24), 3109-3116.

Weissgerber, T. L., Wolfe, L. A., & Davies, G. A. (2004). The role of regular physical activity in preeclampsia prevention. *Medicine and Science in Sports and Exercise, 36*(12), 2024-2031.

Yeo, S. (2010). Prenatal stretching exercise and autonomic responses: Preliminary data and a model for reducing preeclampsia. *Journal of Nursing Scholarship : An Official Publication of Sigma Theta Tau International Honor Society of Nursing / Sigma Theta Tau, 42*(2), 113-121.

Yeo, S., & Davidge, S. T. (2001). Possible beneficial effect of exercise, by reducing oxidative stress, on the incidence of preeclampsia. *Journal of Women's Health & Gender-Based Medicine, 10*(10), 983-989.